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(54)

Resection device for surgical use

A surgical device employs ultrasonic vibrations for the resection of the tissue of a living organism, while the incision so made is being observed by an optical observation tube (8). The resection device (2) possesses: an ultrasonic vibrator (14) for the production of ultrasonic waves, a conical horn (18) connected with said vibrator, and a probe (12) on the forward section of said device (2) for the transmission of the ultrasonic vibrations, whereby the said probe is designed with a rodlike shaft (12a), a distal end section with a resection knife (13) an electrical supply unit (11) to deliver a control voltage on said vibrator (14) and the optical observation tube (8) has a guide opening (6) into which the shaft (12a) of the probe (12) is inserted.

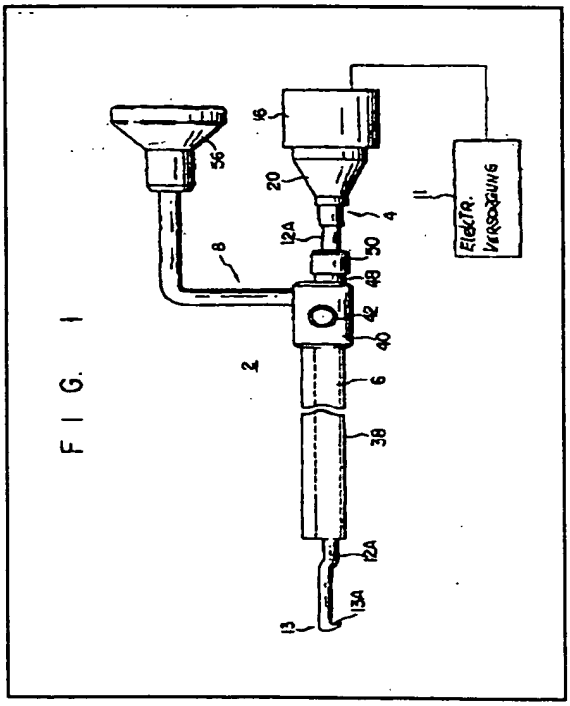

FIG. 1

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CLAIMS

[German column No. 1]
Claimed is:

1. A surgical resection device with an ultrasonic vibrator (14) for the production of ultrasound vibrations, a conical horn (18) connected to the ultra vibrator (14) and an electric supply unit (11) for the conducting of a control voltage to the ultrasonic vibrator (14), characterized by a probe (12, 60) which is connected with the forward section of the horn (18) and serves for the transmission of the ultrasonic vibrations produced by the ultrasonic vibrator (14) and is provided with an end section which possesses a rod shaped shaft (12a, 60d) and a resection knife, and an optical observation tube (8) with a guide opening (6) in which the rod shaped shaft (12a, 60d) of the probe (12, 60) is inserted.

2. A resection device in accord with Claim 1, therein characterized, in that the ultrasonic vibrator (14) contains a Langevin-Vibrations Element.

3. A resection device in accord with Claim 1 or 2, therein characterized, in that the optical observation tube (8) exhibits a second guide opening (41) for the reception of a treatment instrument outside of the probe (12, 60), such as, for instance, a forceps.

4. A resection device in accord with one of the Claims 1 to 3, therein characterized, by a ring shaped part (58) fastened to the shaft section (12a, 60d), by which ring shaped part (58) a wave node is created when the probe (12, 60) vibrates and wherein said ring shaped part is made of plastic.

5. A resection device in accord with one of the Claims 1 to 4, therein characterized, in that the resection knife (13) exhibits a downward protruding blade (13a).

6. A resection device in accord with one of the Claims 1 to 5, therein characterized, in that that the resection knife (13) essentially shows a spoon shape.

7. A resection device in accord with one of the Claims 1 to 6, therein characterized, in that the probe (60), on its distal end section, exhibits a bent end section (60a) with the resection knife (60b).

8. A resection device in accord with Claim 7, therein characterized, in that the bent end section (60a) shows a spherical section (60c) on its distal end.

9. A resection device in accord with Claims 7 or 8, therein characterized, in that the bent end section (60a) is designed in bow form at the proximal end.

10. A resection device in accord with Claim 8, therein characterized, in that the bent section (60a) exhibits two resection knife-elements on its forward or rear side.

11. A resection device in accord with one of the Claims 1 to 10, therein characterized, in that the probe (60) possesses a hollow cylindrical part with a through bored opening (61), which has an opening (61) near to the resection knife (60b) and that is connected to a suction unit (67) by means of a suction tube (66).

[End of Claims}

DESCRIPTION

[German column No. 2]

The invention concerns a surgical resection device with

- an ultrasonic vibrator for the production of ultrasonic vibrations,
- a conical horn connected to the ultrasonic vibrator and
- and electrical supply unit for conducting a control voltage to the ultrasonic vibrator.

Endoscopes, as for instance, resectoscopes, were known to be used for normal observations, diagnoses, and therapies for human tissues under investigation. For instance, if an operating person resects a tissue in question, whereby cauterization with high frequency current is in order, this can be done by the use of a resectoscope, as described in the Japanese Declaration Text 58 81 029.

In this treatment, however, the cauterized tissue will degenerate into a more or less white tissue, so that it becomes difficult the recognize the resection area. The known treatment, then, brings up the problem as to whether or not even normal tissue can be so resected. If the electrode through which high frequency electricity is flowing, accidentally comes in contact with normal muscle tissue of a patient, the muscle tissue reacts and is penetrated, whereby a high degree of bleeding will result.

Thus the invention accepts the purpose of designing a resection device of the kind described in the introductory passages of this patent, by which resection of the tissue in question takes place with the aid of ultrasonic waves without danger of damage to normal tissues, and at the same time, the tissue in question, for instance a cartilaginous tissue, is observed with an optical observation tube.

This purpose will be achieved in accord with the invention by a resection device of the kind described in the introduction, which resection device exhibits the following features:

- a probe, which is connected to the forward section of the horn for the transmission of the ultrasonic vibrations produced by the ultrasonic vibrator,
- a rod-like shaft with an end-section possessing a resecting knife, and
- an optical observation tube with a guide interior in which the rod-like shaft of the probe is inserted.

The resection device in accord with the present invention exhibits a probe with a rod-like shaft and a distal end with a resection knife thereon, while the optical observation tube is provided with a guide opening into which the shaft is inserted. Thus, the operating person can continually observe the tissue in question while it is being resected, so that the danger of damage to normal tissue is avoided.

The invention is to be further described in greater detail with the assistance of drawings presenting preferred embodiment examples. There is shown in:

Fig. 1 a side view of a resection device for a living organism in accord with a first embodiment form of the present invention in which ultrasonic vibrations will be used.

Fig. 2 a side view of the resection unit of the first embodiment,

Fig. 3 a side view with a partial cross-section of the first embodiment,

Fig. 4 a side view of a distal end section of a probe of the resection unit in accord with the first embodiment,

[German column No. 3]

Fig. 5 a plan view of the probe of Fig. 4,

Fig. 6 a side view of an optical observation tube in accord with the first embodiment,

Fig. 7 a cross-section through the optical observation tube of Fig. 6, along the section line II,

Fig. 8 a side view, which shows the probe and the tissue of the living organism to be resected,

Fig. 9 a side, partial cross-section of a modification of the resection knife of the probe in accord with the first embodiment,

Fig. 10 a plan view on the resection knife of Fig. 9

Fig. 11 a side view with partial cross-section of a modification of the probe in accord with the first embodiment.

Fig. 12 a side view with partial cross-section of a resection unit for a resection device for a living organism in accord with another embodiment of the present invention.

Fig. 13 a view from below with a partial cross section presentation of a distal end section of a probe in the device of Fig. 12, whereby the section is made along the line II-II.

Fig. 14 a side view of the distal end cross-section of the probe of Fig. 13 and the cartilaginous tissue to be resected.

Fig. 15 a side view of a first modification of the distal end section of the probe in the device according the Fig. 12 and in

Fig. 16 a side view of a second modification of the distal end section of the probe in the device shown in Fig. 12.

The resection device shown in Fig. 1, in accord with a first embodiment of the present invention is foreseen for use on a living organism wherein ultrasonic vibrations are to be used.

The resection device 2 is comprised of a resection unit 4 and an optical observation tube 8. The resection unit 4 exhibits an ultrasonic vibration generator and the observation tube 8 is provided with a guide opening 6. A probe 12 of the resection unit 4, provided with a rod-like shaft 6 and a distal end section, is set into the guide opening 6.

As shown in Fig. 2, the resection unit 4 possesses a holding encasement 10 which envelopes the ultrasonic vibration generator 14, the probe 12 which fits into the guide opening 6 and an electric supply unit 11.

As is best recognizable in Fig. 3, the encasement 10, is comprised of an outwardly cylindrically shaped housing 16 for the support of a ultrasonic vibrator 14 and a conical outside shell 20 for the containment of a conical horn 18, which is installed in front of the vibrator 14. An outside threaded section 16a is on the external surface of the housing 16, installed near to its opening. The conical outer shell 20 is open at both ends. An inside tapped section 20a is placed on the inner surface of an opening, that is, the large opening. The inner threaded section 20a threadedly engages with the outer threaded section 16a, in order to bind the housing 16 to the conical outside shell 20, thus making, so to speak, one piece.

An annular groove 20c is cut into the inner surface of the opening 20b at the small diameter end of the conical outside shell 20. Between the annular shaped groove 20c and the outer surface of the section 18c of the small diameter of the horn, an O-ring 22 *[German column No. 4]* is inserted. The conical outside shell 20 provides a water tight encasement.

The ultrasonic vibrator 14 is designed as a Langewin-Vibrator and has a forwardly placed metal piece 29, a forward electrode 26, a piezoelectric element and a rearwardly placed electrode 30 plus a rear metal piece 33. The vibrator 14 is secured in the housing with O-rings 23 and 24. An electrode is connected with the electrical supply 11 by a line wire 28, the other electrode also connected through line 32. These line wires are twisted to form a single cable 34. The cable 34 is led out of the housing 16 through the rear side.

The small end section 18c of the horn 18 protrudes from the small opening 20b of the conical shell 20. An outside threaded section 18b is placed on the outer surface of the end section 18c. A connection opening 18a is provided inside of the end section 18c, in order to retain the probe 12. The lengthy probe 12 exhibits a proximal end section 12c and a flange section 12b. The proximal section 12c is fastened in the connection opening 18a and the flange section 12b abuts the end surface of the end section 18c. With the aid of a ring nut 36, the flange section 12b is pressed against the horn 18, so that the probe 12 is affixed to the horn 18. In order to remove the probe 12 from the horn 18, the ring nut 36 is loosened and removed.

A resection knife 13 with a blade extending downward is placed on the distal end section of the probe 12, as may be seen in Figs. 4 and 5..

The probe 12 of the resection unit 4, which has the above described construction, is placed in the optical observation tube 8 as Fig. 6 makes plain. The observation tube 8 exhibits an insertion section 38 with a cylindrical sheath 39, the latter of a hard material, and a main body 40 which is connected to the proximal end of the insertion section. A (not shown) light source unit is attached to the metal piece 42 and is run through light openings 44 and 46, which can be seen in Fig. 7. A tube 48 which borders the guide opening 6, extends rearward out of the main body 40. A rubber hood 50 is snapped over the end section of the tube 45, in order to close the space between the outer surface of the probe 12 of the resection unit 4 and the inner surface of the tube 48. (Fig. 1)

Fig. 7 shows an enlarged section through the insert section 38 of the optical observation tube 8. The tube 48, which neighbors the guide opening 6 for the acceptance of the probe, visual line 52 and the light lines 44 and 46 are brought into the sheath 39 in the insert section 38. These parts are held in their position in the sheath 39 by a filling material 54. As Fig. 6 shows, an ocular 56 is arranged on the end section of the tube 8. The operating person can observe the body incision through ocular 56.

A procedure for the manipulation of the resection equipment for tissues on a living organism, in accord with this embodiment of the present invention will now be described.

In order to resect the tissue in question with this device, an insertion apparatus (not shown) is made fast to an opening of the living organism, and the insert section 38 is guided through the penetration aid. The blade 13a of the resection knife 13 in the

[German column No. 5]

resection unit 4 is positioned at the tissue to be resected, as this is shown by the dotted lines in Fig. 8 while the tissue is being observed through the eyepiece of the optical observation tube 8. If, thereafter, a voltage is sent to the ultrasonic vibrator 14, ultrasonic vibrations are generated thereby and reinforced by the horn 18. The reinforced vibrations are transmitted to the blade 13a of the resection knife 13 by the probe. When the operating person draws the resection unit toward himself, while the blade 13a is vibrating,

the tissue in question will be cut by the blae 13a, as this is shown in solid lines in Fig. 8.

By this method, the tissue is not changed into whitened tissue. The operating person can differentiate the normal tissue from the tissue to be resectioned. Thereby, the normal tissue is not erroneously resected along with the material to be removed.

The shape of the resection knife 13 can be as those shown in the Fig. 9 and 10, that is, made in essentially spoon-like shape. As Fig. 11 shows, a plastic ring 58 from a non abrading material, for instance tetrafluorethylene, can be affixed to the shaft of the probe 12 of the resectioning unit 4, especially at a shaft section at which vibration nodes establish themselves, when the probe 12 is brought to vibrating with ultrasonic waves. In this case, the friction resistance between the probe 12 and the guide opening 6 is lowered and the vibrations from the ultrasonic vibrator can be effectively transmitted without loss to the resection knife 13.

The plastic ring 58 can be affixed to the inner surface of the guide opening 6.

A second guide opening 41, which is shown in Fig. 7 in dotted lines, can be provided in the sheath 39 of the inserted part 38, in order to allow the introduction of a treatment instrument, for instance, a forceps, outside of the resection unit 4.

The probe 12 on the distal end section of the horn 18 can be fastened, for instance, by hard soldering. By this measure, the ultrasonic transmission loss is further reduced.

The probe 12 can be designed with a hollow cylindrical part with a (not shown) completely penetrating boring (not shown) and said boring can be connected to a suction means. In this way the cut-away tissue is transported out by the said suction.

In Fig. 12, a resection unit in an ultrasonic resection device in accord with another embodiment of the present invention is shown. In this embodiment, the resection unit has essentially the same construction as the above embodiment. The drawing reference numbers describe the same parts in the second embodiment and a detailed description thereof can be dispensed with.

The ultrasonic unit in Fig. 12 shows a rod 60, which corresponds to the probe of the resection device of the previous embodiment. A hollow space 61 in the rod 60 is defined, which possesses a lengthy shaft 60d.

The hollow space 61 communicates with a penetrating opening 62 in the horn 18. The opening 62 communicates with a connection tube 64, which latter runs through the vibrator 14. The connection tube 64 is installed in a through-opening 16b in the rear

[German column No. 6]

section of the housing 16 and held fast therein by an O-ring 25. The connection tube 64 protrudes to the rear out of the back section of the housing 16, and is connected with a source of suction by means of a hose 66. The electrodes of the vibrator are connected with an electrical supply unit 11.

The distal end of the rod 60 is bent and forms an L-shaped, bent section 60a. A measuring element 60b, which corresponds to that of the foregoing embodiment, defines the backward end of the bent section 60a. A rounded section 60c, possessing essentially a spherical shape, is placed at the distal end of the bent section 60a and an opening 61a of the hollow space 61 is found near to the knife 60b.

The function of the resection unit, in accord with this embodiment will now be described, whereby a cartilage tissue in a knee joint hollow is resected.

A joint position of a knee, or other joint, will be bored through in order to make an opening. The rod 16 is introduced into the opening directly or with the help of an insertion device.

A (not shown) arthroscope is inserted into the opening in the joint from another position. The operating person brings the distal end of the rod near to the cartilage tissue in the joint opening, as this is shown in Fig. 14. When this is done, the distal end of the rod 60 is observed with the arthroscope. The knife 60b placed in the rod 60 is now adjacent to the cartilage tissue 68.

The supply unit 11 is now switched on to start the vibrator to vibrate and at the same time, the suction source 67, which is connected through hose 66, is turned on.

The ultrasonic vibrations which are produced from the vibrator 14 are conducted to the rod 60. The knife 60b of the rod 60, which knife now ultrasonically vibrates, is carefully moved forward or back, vertically or laterally, in order to remove the cartilage tissue 68.

The cartilage tissue now cut away is transported by the suction unit 67 through the hollow space 61 of the shaft 60d of the rod 60 through the exit opening 62 and the hose 66.

The spherical section 60c has a smooth surface and is placed on the distal end section 60a of the bent rod 60. Even when the distal end of the rod 60 erroneously comes in contact with normal tissue while the knife 60b moves lightly forward and back, or vertical or sideways, in order to cut or remove the cartilage tissue 68, the surfaces contacting normal tissue are smooth and curved. Therefore, the normal tissue is not destroyed.

Fig. 15 shows another modification of the rod of the resection unit in accord with this embodiment. In this case, the bent section 60a of the rod has a spherical end section 60c on the distal end and a knife 60b is placed on both sides of the bent section 60a.

Although this is not presented in illustration, the knife and a bent shaped section *[German column No. 7]*
on the distal end of the rod can be made without designing an off-set end section.

In summarizing: the knife is designed to be on the distal end of the vibrating rod, which vibrates with ultrasonic waves in the resection unit of the second embodiment and the smooth, bent shaped section is designed to be formed about the distal end of the knife. Thus normal tissue is not destroyed by the distal end of the knife, when the tissue of the living organism is resected.

[This completes the assigned text of DE 37 07 403]

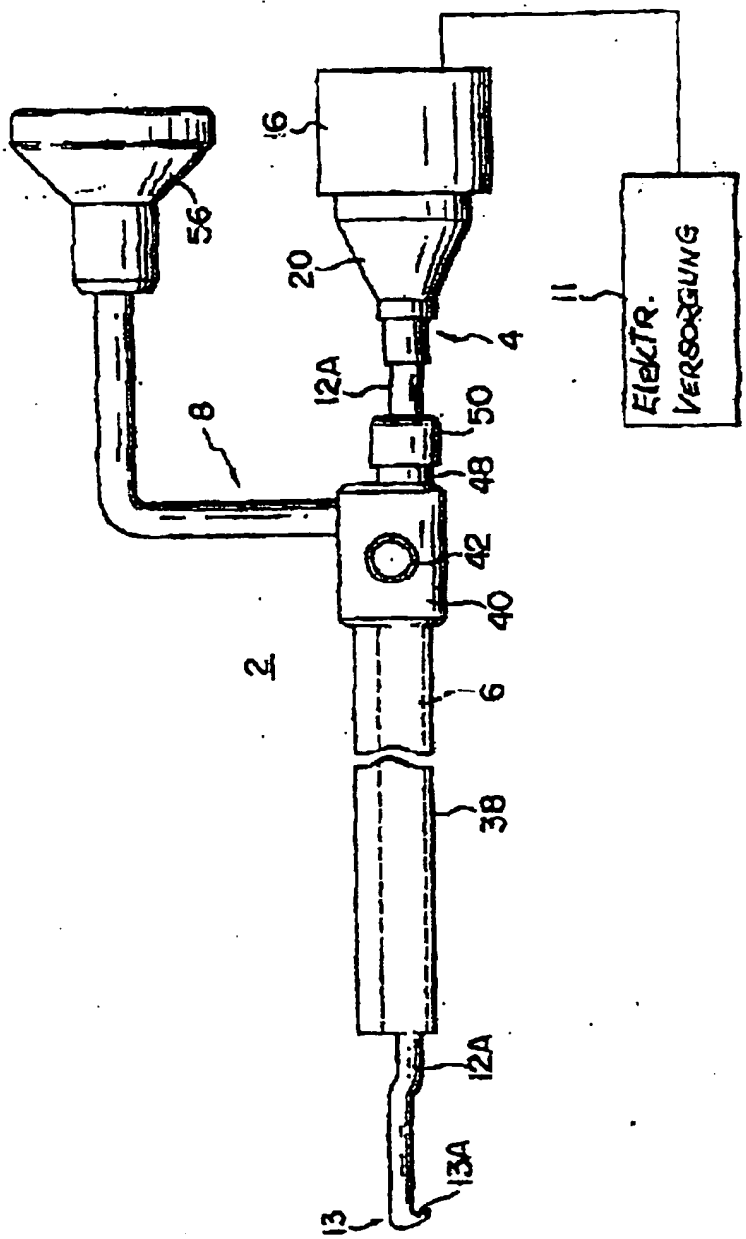


FIG. 1

FIG. 2

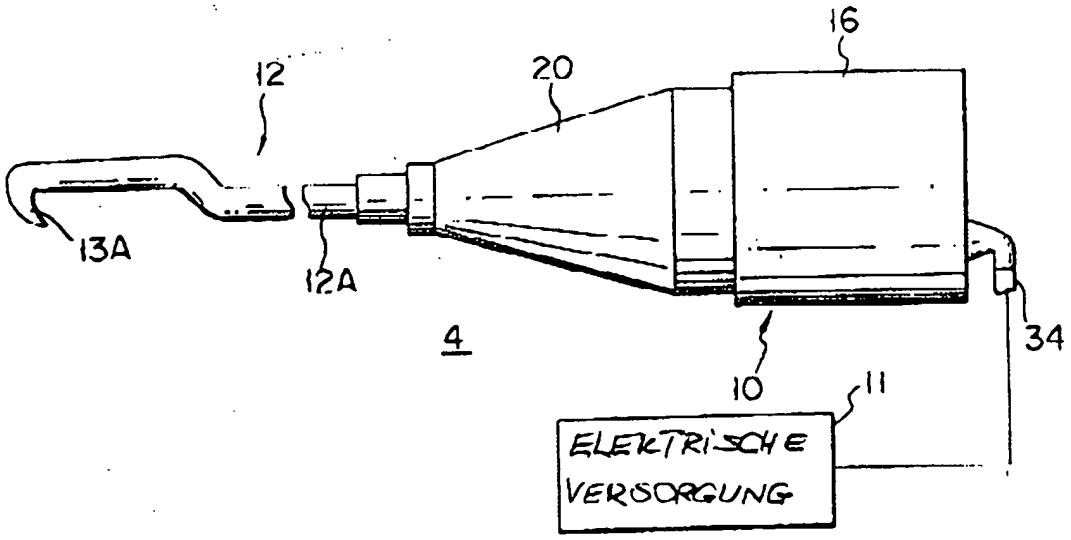
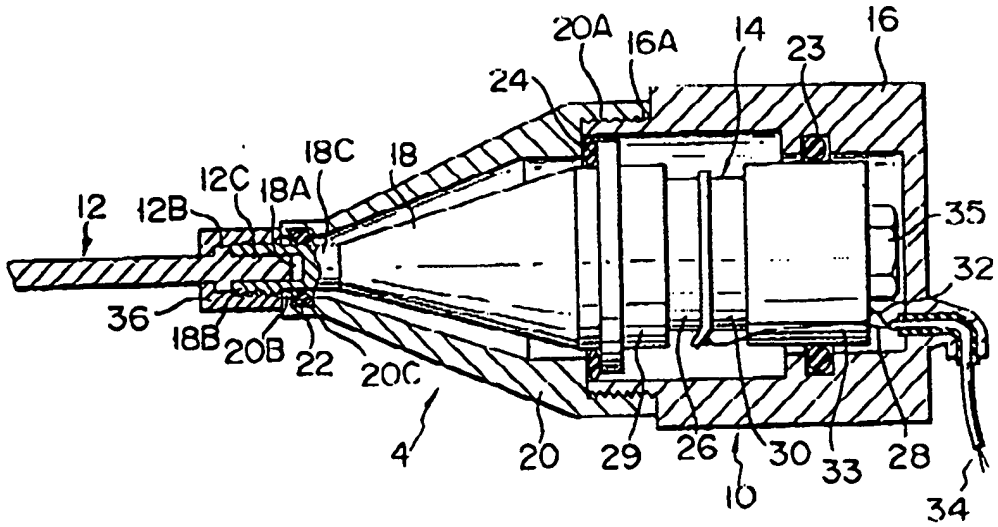

16
12
20
13A
12A
4
34
10
11
ELEKTRISCHE
VERSORGUNG

FIG. 3


20A
16A
14
23
16
24
18C
18
12C
18A
12
12B
35
32
36
18B
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22
20C
4
20
29
26
30
33
28
10
34

FIG. 4

FIG. 5

FIG. 6

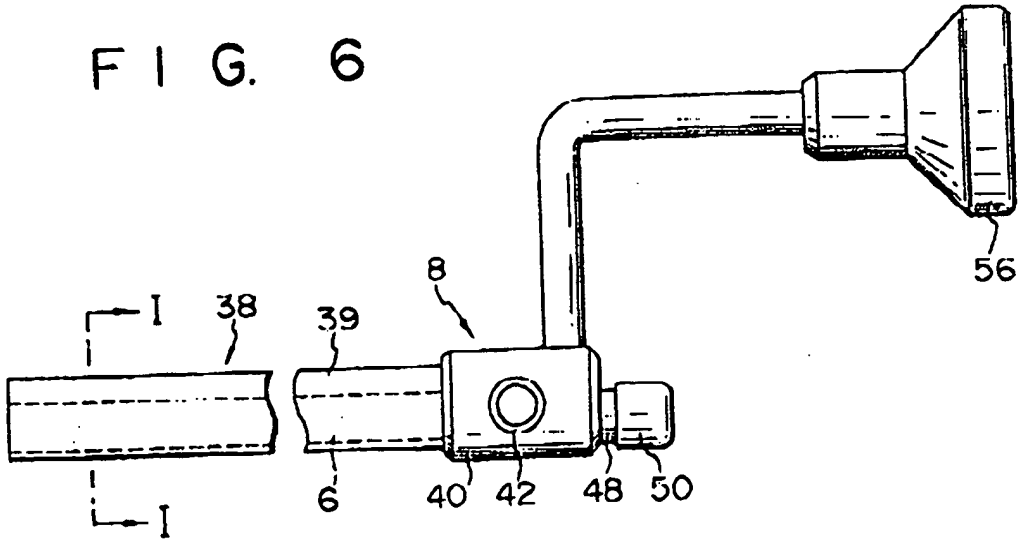

FIG. 7

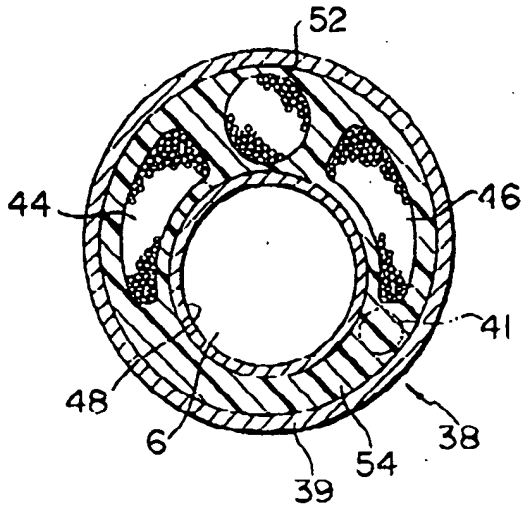

FIG. 8

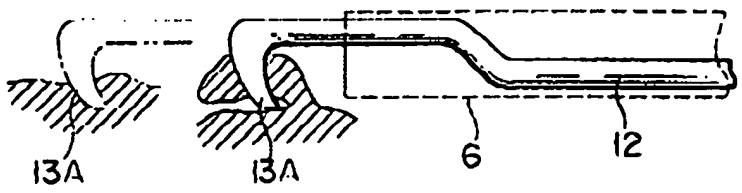

FIG. 9

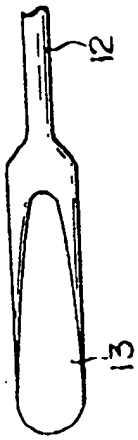

FIG. 10

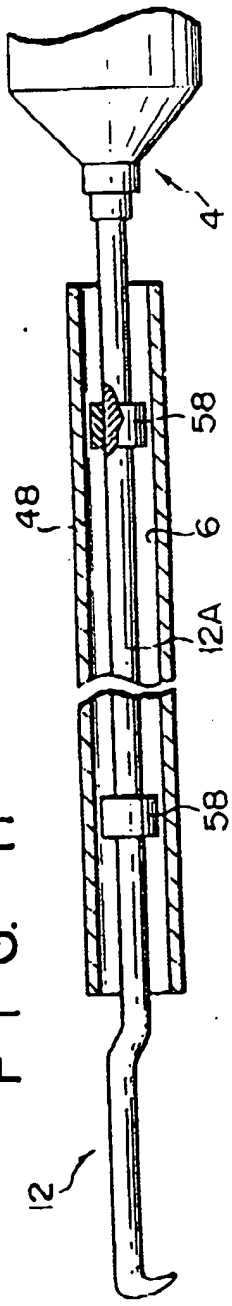

FIG. 11